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Culture-Fair Assessment: Challenging Indigenous Students Through Effortful Mathematics Teaching

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Introduction

This paper reports on a mathematics education research project centred on teachers' pedagogical practices and capacity to assess Indigenous Australian students in a culture-fair manner. The project has been funded by the Australian Research Council Linkage program and is being conducted in seven Catholic and Independent primary schools in north Queensland. Our Industry Partners are Catholic Education and the Association of Independent Schools, Queensland.

The study aims to provide greater understanding about how to build more equitable assessment practices to address the issue of underperforming Aboriginal and Torres Strait Islander (ATSI) students in regional and remote Australia. The goal is to identify ways forward by attending to culture-fair assessment practice. The research is exploring the attitudes, beliefs and responses of Indigenous students to assessment in the context of mathematics learning with particular focus on teacher knowledge in these educational settings in relation to the design of assessment tasks that are authentic and engaging for these students in an accountability context.

This approach highlights how teachers need to distinguish the 'funds of knowledge' (González, Moll, Floyd Tenery, Rivera, Rendón, Gonzales & Amanti, 2008) that Indigenous students draw on and how teachers need to be culturally responsive in their pedagogy to open up curriculum and assessment practice to allow for different ways of knowing and being.

Culture-Fair Assessment

Berlack (2001), as cited by Luke, Woods, Land, Bahr & McFarland (2002, p. 11), argued that "students from a non-dominant culture experience testing as a form of cultural intimidation." As these authors indicate Berlack's key point is "that students from particular ethnic and racial groups may actually develop attitudes and practices of resistance to the surveillance, judgement and categorisation practices that are affiliated with large-scale testing." Culture-fair testing is not an attempt to favour, in any way, the culturally different group. However, it is recognized that cultural differences can impact on performance in the context of standardised tests such as National Assessment Program for Literacy and

Numeracy (NAPLAN). The variables that may influence test performance that have been identified by Luke et.al (2002) include:

- the cultural-specificity of how the task or activity in question is framed;
- the cultural-specificity of the normative models of child and adolescent development reflected in the domain specification and constructs of the test;
- the linguistic codes and conventions of the test and task;
- the cultural-specificity of content knowledge.

The concept of culture-fair assessment (Berlack, 2001; Luke, et al., 2002) builds on insights gained from the previous year's work of this project when issues of access and fairness were identified (Klenowski & Gertz, 2009). The opportunity for Indigenous students to participate in learning and assessment, and the opportunity to demonstrate their learning, were identified as fundamental for addressing equity issues in assessment. Findings related to language, and the students' socio-cultural circumstances, need to be understood by teachers, principals and policy officers responsible for designing and developing assessment examinations and tests.

Context and Background

Patterns of under-achievement by Indigenous students are reflected in national benchmark data such as that of the NAPLAN and international testing programs like the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA).

A trend of underperformance in terms of equity has continued over the past six years as evident from the comparative analyses of PISA results, first administered in 2000, again in 2003, and in 2006. De Bortoli and Thomson (2009, 25) state:

"In PISA 2000, Indigenous students achieved a mean score 86 points lower than that of non- Indigenous students. The large differences in mathematical literacy performance continued in subsequent PISA cycles, with Indigenous students performing 86 score points lower than non-Indigenous students in PISA 2003 and 80 score points lower in PISA 2006. In mathematical literacy, one proficiency level equates to 62 score points. Indigenous students also performed significantly lower (by almost one proficiency level) than the OECD average."

There is consistent data across all levels - school, state, national, and international - to conclude that Australian schools are not addressing equity issues effectively (DEST 2007, Sullivan, Tobias and McDonough 2006) with Indigenous children scoring significantly lower than non-Indigenous children (De Bortoli and Thomson 2009). The research suggests that the performance of Indigenous students in numeracy relative to that of the rest of the school population declines as the period of time spent at school increases (DEST 2007).

Indigenous Mathematics Assessment Program

The Australian Curriculum: Mathematics and each of the eight state based curricula emphasise equity and the engagement of 'all' students in mathematics education. However, many students are disengaged and lack enthusiasm for learning mathematics. The recent Group of Eight's (G08) *Review of Education in Mathematics, Data Science and Quantitative Disciplines* (Brown, 2009) suggest that "the state of the mathematical sciences and related quantitative disciplines has deteriorated to a dangerous level" (p.3). Critically this has led to a decline in the

number of students studying the more demanding mathematics subjects at the pre-university level.

Recent NAPLAN data reveal that there is a significant drop in average numeracy scores when metropolitan to regional schools are compared similar to the difference between regional schools and rural/remote schools. Clearly, there is a lack of parity in mathematics achievement between rural and remote students, including Indigenous students, and their capital city peers. Rural and remote Australian schools, which are the focus of this study, are faced with many obstacles including the:

- lack of qualified mathematics teachers and the necessity to employ non-specialist mathematics teachers (ACDS, 2006).
- capacity of rural and remote communities to recruit and retain suitably qualified mathematics teachers. This is especially evident in Queensland schools (Queensland Board of Teacher Registration, 2005). Attracting teachers is challenging, often these teachers are young and in-experienced. However, retaining these teachers in rural communities is problematic with many rural schools experiencing a high annual turnover of staff.
- average age of experienced mathematics teachers is nearing retirement age. It is expected that many mathematics teachers will leave the system in the near future, further exacerbating rural school concerns.
- reduced access to teacher professional development and on-going support due to large travel distances and the lack of replacement staff.
- increasing need for appropriate community role models to support rural and remote students' decision making, especially in regard to identity and future career options (Alloway, Gilbert, Gilbert and Muspratt, 2004).
- decline in the number of students who are studying higher-level mathematics at school (ACDS, 2006, p.iv; Victorian Parliament, 2006, p.204, McPhan et al, 2008).
- inability to be successful in addressing inequalities. Lokan et al. (2001), for example, argue that recent curriculum reforms have failed to address the obvious disadvantage of particular groups of students, and have not resulted in significant gains in engagement, especially in the middle years of schooling.
- McGaw (2004) claimed that Australia is performing worse than other developed countries in regard to equity. He categorised Australia as high in quality but low in equity. In other words, while the achievement of students overall is high, there are wide differences between the high and low achieving students (Sullivan, Tobias & McDonough, 2006).
- Queensland students fall below other Australian states with Indigenous students scoring the lowest.
- The 2006 PISA results compared the responses of the commonly discussed equity groups with 15 year-old students. The SES socioeconomic backgrounds of students is a clear indicator determining the chance of success. There are similar differences when comparing Indigenous and non-Indigenous achievement, and similarly between metropolitan and rural/remote students.
- Low SES students are five times more likely to be represented at level 1 or below in the PISA numeracy achievement results than high SES students. Equally, high SES students are five times more likely to be represented at the highest level of achievement than low SES students (NCB, 2009).

Contextually, this research project has focused on the factors for success of

Indigenous students in learning mathematics. Indigenous Australian children and adolescents are achieving poorly in Australian schools and perform well below non-Indigenous students (Masters, 2009). McTaggart and Curro, (2009) in a Far North Queensland study suggest that fundamentally “there are many complex and interacting causes of the underachievement of Indigenous student ... and that a vast number of Indigenous Australian students are speaking at least one Indigenous language and no English when they are not in classrooms” (p.6).

The languages used, orally only, by students in schoolyards, at home and in recreation may range from traditional languages, through clearly identifiable creoles, to several dialects, sometimes termed 'Aboriginal Englishes' which are similar to each other but locally specific. Students may use any or all of these, together, or separately, or intermittently with subconscious code-switching. Standard Australian English is almost never used. So, in schools, students are usually learning English as a second or third language (McTaggart & Curro, 2009, p. 6).

Facility with Standard Australian English is assumed in the ACARA Australian Curriculum: Mathematics as it is in current state based curricula. It follows that students whose first language is not English need very careful teaching in language in the mathematics classroom. The *Language of Maths* study conducted in Far North Queensland explained that the “imperative need to explicitly focus on language has become increasingly evident throughout the project with anecdotal evidence reporting that students demonstrated that they may have the requisite knowledge and skills, but language can be a barrier to communicating knowledge” (Davidson, 2005, p. 8). Chris Sarra suggests that for Indigenous students to succeed, “the magic bullets are: embracing a positive Indigenous student identity; Indigenous leadership in schools and communities; high expectations for teacher-student relationships; and innovative, flexible and receptive staffing and school modeling” (Sarra, 2009).

Other researchers in mathematics education have focused on student disengagement as a particular concern in the middle years, the motivation, resilience and persistence of students. Clearly teachers are subsumed with pressure to meet syllabus outcomes and national testing expectations with a diverse range of students. However, many Australian students, it seems, are simply bored with learning without understanding and are looking to be challenged and engaged in mastering the concepts and processes of mathematics in a meaningful manner.

The Maths Program

The mathematics program at the centre of this study in Far North Queensland focuses on learning mathematics through problem solving and open-ended questions. The underlying endeavour is to engage students in mastering as opposed to adopting a performance view or set of beliefs about learning mathematics (Dweck, 2000). In seeking to understand the basis for the decisions that students make, we sought to investigate the dispositions to, and capacity for, self-regulation, with a key being to understand how students see themselves. The underlying model was derived from the work of Dweck (2000) who identified two perspectives on intelligence. One is a fixed perspective of intelligence entitled *entity* theory in which people believe that their intelligence is predetermined at birth and remains fixed through life. Dweck suggested that students who believe in the entity view require easy successes to maintain motivation, and see challenges as threats. The alternate perspective is where students see intelligence as malleable or *incremental* and they can change their intelligence and/or achievement by manipulating factors over which they have some control. Students with such incremental beliefs often choose to

sacrifice opportunities to look smart in favour of learning something new. Not only their goals but also their needs regulate particular outcomes.

Students are more likely to participate in mathematics if they value or are interested in the subject. McPhan et al. (2008) reported that students' lack of interest and liking for mathematics during their middle school education was an important one of five factors, the others being: their previous achievement in mathematics; their mathematics self-concept; and, their perceptions regarding the usefulness and difficulty of mathematics. Of these five factors, evidence suggests that the first is dominant (Watt, 2005; Wigfield, Tonks, & Eccles, 2004).

In this program effortful learning and teaching strategies are emphasised whereby teachers are encouraged to adopt a diagnostic role to identify students' background abilities and dispositions to learning mathematics. Productive dispositions are described as part of an *interwoven and interdependent strand* of proficiencies, defined as – “habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own self efficacy” (Kilpatrick, Swafford & Findell, 2001, p.5). Kilpatrick, Swafford and Findell's *Adding it Up* recommendations are a platform for development of the Australian Curriculum: Mathematics (ACARA, 2009, p. 5). Therefore achieving a sense of cultural awareness with classroom teachers and teaching aides (Indigenous education aides) is a fundamental goal for pedagogical decisions and for gaining a greater awareness of what individual students might be capable of and how they might best learn. By viewing teaching and learning as something intertwined the teacher has a greater opportunity to understanding the developmental sequences in mathematics in relation to the student's conceptual and procedural knowledge base in light of their disposition to learning. Effortful teaching encompasses the complex nature of the classroom environment with a more aware and intuitive approach to assessing students via rich and challenging tasks and open-ended questions.

Interestingly, the approach utilized by the research project is largely consistent with the proposed ACARA national curriculum, “adapted from the recommendations in *Adding it Up* (Kilpatrick, Swafford & Findell, 2001)” (NCB, 2009, p.5) with the inclusion of the Productive Disposition proficiency strand that has not been included in the Australian mathematics curriculum. Productive Disposition, in *Adding it Up* is described as part of an interwoven and interdependent strand of proficiencies and defined as – “habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own self efficacy” (Kilpatrick, Swafford & Findell, 2001, p.5).

Research Focus

This paper is based on the second year of a larger research study that is particularly timely and necessary against the background of Australia's underachievement in terms of equity for Indigenous students and the lack of an informed strategy in the Education sector to counter this trend. The key research questions for the main study are:

- What are the properties of teacher constructed mathematics **assessment tasks** that are culture-fair?
- What are the **culturally-relevant assessment practices**, as enacted in classrooms using these mathematics tasks, with a significant number of ATSI students?

- Does the use of culture-fair mathematics assessment tasks lead to **improved learning for ATSI students** as measured by the national statements for learning, the national Numeracy Benchmarks and years 3 and 5 numeracy testing?
- In a standards-referenced context how can teachers **develop their assessment capacity** so that more appropriate support and assistance is given to Indigenous students to improve their learning?

This paper builds on findings from 2009, the first year of the project, involving three schools. In 2010, a further four schools have been involved in this second phase that focuses on developing teachers' assessment capacity in mathematics to address issues of equity and culture-fair assessment. In this phase Year 4 and 6 Indigenous students were again interviewed, as were their teachers, the Indigenous education aides and the principals about their attitudes and responses to assessment in the context of mathematics learning. The preliminary findings of this paper are derived from a sociocultural theoretical framework and methodological approach that are now discussed.

Sociocultural Theoretical Underpinnings

Sociocultural theories of assessment and learning (Rogoff, 1995, 2001, 2003; Wertsch, 1991, 1995; Gutiérrez, 2009), authentic assessment (Wiggins, 1989, 1990, 1993; Stiggins, 1987, 2007) and assessment for learning (ARG, 1999; Stobart, 2008) underpin the theoretical and methodological approaches adopted. Sociocultural theories of learning and assessment in the context of this study have helped in explaining the concept of culture-fair assessment as more of a social consideration rather than a technical concern. The research to date has found that culture-fair assessment requires an understanding of issues to do with the literacy demands of mathematical items, language and tasks and the validity and fairness of the assessment practices.

Sociocultural approaches have their origins in Vygotsky's (1978) premise that thought, or the mind, is developed in the conditions in which an individual is socialised. Prior experiences thus shape a child's development and strongly influence how they encounter and deal with the curricula presented by a school and the expectations of teachers who are former students of the same system. As Vygotsky contends the processes of development begin collectively and the formation of a social being is a gradual move from the social into an individual world outlook¹. Vygotsky's point, of looking to the conditions of socialisation to understand a child's present learning potential, has been a core of sociocultural theory and its variants. The goal in both theory and research is to create models of educational activity in which all actors, taken to be embedded in a system (school, hospital, firm, etc), share cognition and some situated understanding of the way it functions, and their place within that system. A common goal within sociocultural theories is first to examine how learning and cognition are dispersed within a setting and second, to focus attention on a future object, such as a common or shared purpose of improving learning for all involved. As such, research involves a process of acculturation for participants and researchers (Rogoff, 1995, 2003).

¹ Vygotsky (1976) developed a social psychology immersed in the communist and Russian ideals of collectivism in opposition with assumptions of an isolated individual, the homo-economic of capitalism, implicitly directing Western psychologies of his contemporaries, particularly Piaget (c/f Bruner, 1986 Ch5).

The direction we are taking can be illustrated with reference to Engstrom's (2000) use of activity theory. Engstrom advises that activity is driven by communal motives, which differ across participants in a system. They vary according to what he calls the goal-directions of individuals, which can be short-lived and the more durable system goals. Moreover, these goals have a tendency to be internally contradictory. The purpose for an intervention, he says, is to question participants in its initial stages to have them uncover aspects of their daily practices that they might find difficult to articulate. The intention from this is to begin cycles of expansive learning that can be directed to an implementation of improved forms of practice, as a common object and renewed goal-directions. The effect of an intervention relies on participants reducing a zone of proximal development between existing and future forms of organisation of goals and practices.

Engstrom's (2000) line of reasoning aligns with the intentions of this second phase of research into culture-fair assessment for Indigenous students as it was designed primarily to uncover contradictions in the goal-directed activities of individual participants and to examine these against goal-oriented system motives of the schools. The object has been to situate NAPLAN testing, pedagogy in mathematics and new forms of assessment as a common goal to be worked towards by Indigenous students, teachers, Indigenous education aides and principals. The study is aimed at exploring variations in individual and system goals within this sociocultural framework. At this stage of the project it is too early to confidently identify factors that might be contributing to the zone of proximal development between existing and future forms of organisation of goals and practices. Some insights into the implications for future development can be seen however from the preliminary results as presented.

Methodology

The project is in the second phase of a 'design experiment' (Brown, 1992, Kelly, 2003)². This research design involves an iterative approach to classroom intervention in which Indigenous students, school staff and researchers provide practical theorised views on mathematics learning and insights into how pedagogy and assessment could be improved and made more challenging. The research design, the interview methods, analyses of NAPLAN data and the more "messier" (Gorard, et al: 2004: 580) aspects of planning in a university environment and working *in situ* in the schools are now described.

The research has involved a number of data sources that include: a fine-detailed analysis of the NAPLAN data of the Year 4 and 6 Indigenous students' responses from the four focus schools; an analysis of socio-cultural factors which might have influenced their scores (such as cultural specificity of how the item or question was framed, the linguistic codes and conventions of the test, cultural-specificity of content knowledge, possible misinterpretation of questions); a disposition survey of the individual Indigenous students, completed by teachers; relations between a school, Indigenous students and families; the cultural and pedagogic understandings Indigenous Education Workers bring into classrooms, the attitudes and dispositions of Year 4 and 6 teachers and senior staff to Indigenous students and their learning.

The Year 4 and 6 teachers were provided with the analyses of the NAPLAN numeracy data on the first visit to the school in 2010. The teachers were informed about the results and it was suggested that these be used to inform teaching decisions and the development of rich assessment tasks. The aim of the project is to

² An overview of methods and the design of the first stage can be found in Klenowski and Gertz, (2009).

build teachers' assessment capacity so that they can use summative assessment data formatively to scaffold and extend Indigenous students' mathematical understandings. Each school principal and the Year 4 and 6 teachers involved in the project have now received these detailed summaries of each Indigenous student's responses to the NAPLAN test. Each question has been analysed so that teachers can check each student's answers to the different mathematical strands. The descriptive analysis of each answer aims to support a more comprehensive understanding of the underlying concept and to suggest the next steps to be taken to support the student's development in the identified mathematical concept in need of improvement.

Follow-up interviews have been conducted with the Year 4 and 6 teachers concerning their pedagogical approach with Indigenous students, students' reactions to challenging tasks and the support available for Indigenous students and for the teachers, themselves, in their schools.

Semi-structured focus group interviews have also been carried out with the Year 4 and 6 Indigenous students, interviews have also been conducted with principals and with Indigenous education aides (e.g. teacher aides, community liaison staff, education workers) to gain a broad view of cultural influences and values that affect the dispositions of Indigenous students' learning, particularly in relation to mathematics. The background information from these interviews has been analysed further to augment data from the individual NAPLAN test results.

The overall aim has been to identify homologies ('resemblances with a difference') between classroom interaction, school organisation designed for Indigenous students, their education and culture, and relationships with home and family in each regional setting. Attention to the variation that emerges in the results across a continuum of Indigenous learning is further analysed to explore the factors for culture-fair assessment.

As the research is exploring the attitudes, beliefs and responses of Indigenous students to assessment in the context of mathematics learning with particular focus on teacher knowledge in these educational settings, concrete methods are to be introduced in relation to the design of assessment tasks that are authentic and engaging for these students. This will occur during the next visit to the schools. The methods to develop authentic school assessment tasks will be developed based on the analysis of the data collected. The interventions and researcher-modelled pedagogy will be the focus of the next round of analysis that will again involve semi-structured interviews.

The semi-structured interview questions will focus on the emergent themes and content related to the aims of the project which include:

- Inquiry into teachers' assessment capacity to achieve high quality learning for Aboriginal and Torres Strait students through attending to culture-fair assessment tasks and practices in the field of mathematics, and
- Evaluation of whether teachers' (including Indigenous teachers and Indigenous Education Workers) use of more culture-fair mathematical assessment tasks and practices provide greater equity.

To date most of the semi-structured interviews have opened with a 'grand tour' question to which each interviewee could respond with details about his or her

background and role in the school; and demographic information. The remaining questions centred on Indigenous dispositions to school subjects, relations to NAPLAN, what the school has learnt and is still learning from working with Indigenous students (with Indigenous Education Workers). Similar questions were asked of teachers relating to their understanding of socio-cultural contexts of Indigenous students and culture fair assessment. Principals too were asked about: the school philosophy and the part played by Indigenous students in the school; attitudes and dispositions to completing maths activities; strategies for teaching Indigenous students. Students in the focus groups were interviewed about their likes and dislikes in maths, what they felt they were learning in maths and how teachers and others might help them to be better at maths.

Preliminary Findings

The analysis of some of the data sets will now be presented to highlight the preliminary findings of this phase of the project. Given the limits of the paper it is not possible to provide all analyses.

The four principals when interviewed indicated their support for this study because of the opportunity that it provides for learning by both teachers and students, for breaking down the sense of isolation experienced by regional and remote schools and by building teacher assessment capacity. The findings of this phase of the study have implications for pedagogy and for assessment practice. Culture-fair assessment encourages teachers to engage students in appropriate levels of challenge through relevant and meaningful contexts for identifying conceptual and procedural understanding in light of the student's disposition and desire to learn mathematics. When asked what culture-fair assessment meant the four principals emphasised the importance of the tasks to be well written, to take account of the different backgrounds and cultures of Aboriginal and Torres Strait Islander students, to be easily understood and to link to the Indigenous students' experiences.

The analysis of the student data revealed some interesting gender trends in relation to Indigenous students' attitudes and preferences about challenging mathematical tasks. Overall 39 Indigenous students were interviewed (24 female and 15 male students). From Year 4, twenty students (12 female and 8 male students) were interviewed and from Year 6, nineteen students (12 female and 7 male students) were interviewed.

Table 1. Student responses to the question "Do you like learning maths?"

Year	Number of Students	Yes	No	Mixed Feelings
Year 4	20	19 (95%)	1 (5%)	
Male	8	7 (88%)	1 (12%)	
Female	12	12 (100%)		
Year 6	19	12 (63%)		
Male	7	7 (100%)		
Female	12	5 (42%)	2 (16%)	5(42%)

As Table 1. indicates, it is interesting to note that only 12 out of the 19 Year 6 students interviewed said that they liked learning maths (63%) whereas 95% of the Year 4 students said that they liked learning maths. This difference in results is largely due to the number of girls in Year 6 (58%) who said that they either didn't like learning maths or had mixed feelings about it. The results for the boys remained consistently high across both year levels (Year 4- 88% said that they liked learning maths and Year 6- 100%). This gender difference requires further investigation.

The two students who didn't like maths said that they found maths boring and difficult at times. The five students with mixed feelings said that they found it easy at times but hard and frustrating at other times. One student commented:

"I enjoy it but sometimes I get stuck on a lot of questions."

The remaining 31 students who said that they liked learning maths gave the following reasons:

- Most students said that they enjoyed learning mathematical concepts and appreciated the practical applications of the concepts e.g. in being able to count money and share lollies with friends using division.
- Three students said that they liked maths because "It makes you smart" and three students liked it because it was challenging and kept their minds active. One male student commented: "I like to make the brain work". Of these six students only one was female.
- The female students tended to like maths because they were good at it and found it easy and fun.
- Other students liked maths because it gave them a good education which would lead to a good job.

Table 2. Student responses to the question "How good do you think you are at maths?"

Year	Number of Students	Good	Not good	Okay	Unsure
Year 4	20	7 (35%)	1 (5%)	10 (50%)	2 (10%)
Male	8	4 (50%)		2 (25%)	2 (25%)
Female	12	3 (25%)	1 (8%)	8 (66%)	
Year 6	19	12 (63%)	2 (11%)	5(26%)	
Male	7	6 (86%)	1 (14%)		
Female	12	6 (50%)	1 (8%)	5(42%)	

Table 2 indicates that overall 19 (9 female and 10 male) out of the 39 students interviewed (49%) thought that they were good at maths,

In Year 4, 85% of students thought that they were either good or okay at maths and in Year 6, 89% of students thought that they were either good or okay at maths. It is interesting to note that overall, 66% of male students interviewed thought that they were good at maths compared to 38% of female students and 54% of female students regarded themselves as okay at maths compared to 13% of male students.

Table 3. Student responses to the question “Do you like easy or hard maths questions?”

Year	Number of Students	Easy	Hard	Both	In between	Don't know
Year 4	20	5 (25%)	9 (45%)	5 (25%)		1(5%)
Male	8	1 (12%)	3 (38%)	3 (38%)		1(12%)
Female	12	4 (33%)	6 (50%)	2 (17%)		
Year 6	14	6(43%)	4 (29%)	2 (14%)		2(14%)
Male	5	0%	4 (80%)	1 (20%)		
Female	9	6 (67%)	0%	1(11%)	2 (22%)	

Overall 38% of students said that they liked hard maths questions, 32% said that they liked easy maths questions, 21% said that they liked both easy and hard maths questions, 6% said that they liked ‘in between’ easy and hard maths questions and 3% didn’t know.

Again, when analysing according to gender it is interesting to note that 9 out of the 21 (43%) female students interviewed liked ‘hard’ or ‘hard and easy’ maths questions compared to 11 out of the 13 (85%) male students. One female student who liked easy maths questions said, “They’re not as hard as the hard ones, like easy does not confuse you.” One male student commented, “It’s just because you’re learning more when it’s hard.”

These preliminary results indicate that there are significant gender differences in the students’ enjoyment of maths, self-perception of how good they are at maths and the level of challenge they like in maths questions. These gender differences require further investigation to determine if there is a trend towards Indigenous girls losing interest and underperforming in maths as they progress through school.

Disposition Survey

The teachers were asked to complete an adapted version (Yates, 2009) of the *Student Behavior Checklist* (Fincham, Hokoda, & Sanders, 1989) for each Indigenous student in their Year 4 or 6 class. Yates conducted an analysis of the checklist to gain a “psychometrically robust Rasch calibrated ‘Student Behaviour Scale’ ” (2009, p. 86) for teachers to identify students exhibiting debilitating behaviours, such as learned helplessness, in the classroom. This scale was further adapted for the purposes of this study. Consequently a 12-item likert scale disposition survey has been devised to gain an insight into how the teachers see their students (N=44) in relation to learning mathematics.

Interestingly the following preliminary findings suggest that it is difficult to generalize the perceptions and aspirations of Indigenous learners. When the teachers were asked a preference question in regard to doing easy maths tasks or hard task, two-thirds of the students were seen as resilient learners who like to struggle on until they get an answer. Half of the students were reported to be enthusiastic mathematics learners. However, only one-third of the students enjoyed challenging tasks and half of the students persisted before asking for help. Interestingly, two-thirds of the students preferred 'straight forward tasks'. This suggests that there may be some compliance teaching and learning occurring in some classrooms as three out of four students preferred to do easy tasks. Therefore teachers may be providing lower level tasks for students to engage with and students were responding with a compliant attitude.

To be seen as valued members of a mathematics learning community, students need to decipher the cultural relay of mathematics classrooms and participate in ways that align with the accepted norms of that classroom. (Zevenbergen, Mousley & Sullivan, 2004, p. 395) This is not always possible for Indigenous students who have particular language and cultural needs that do not readily align with those of the classroom. This finding became evident from an analysis of the interview data of Indigenous staff.

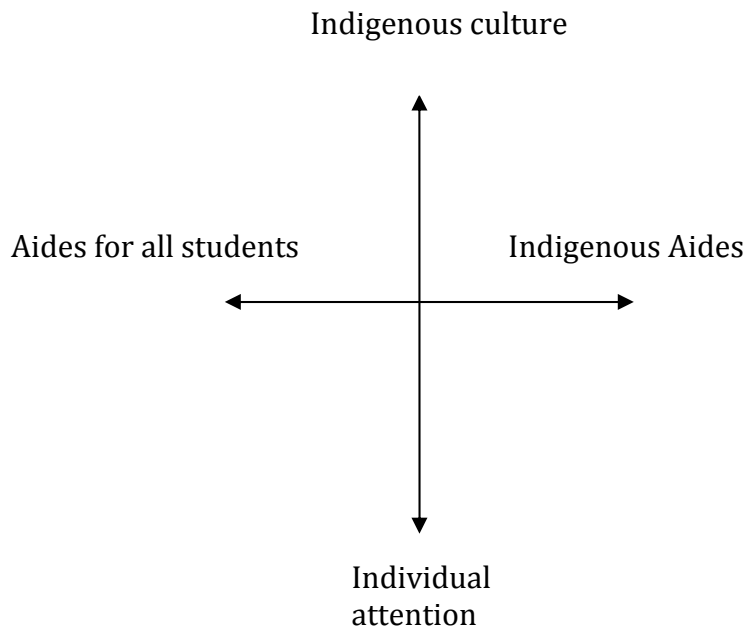
Indigenous staff positioning within school organisation

The views of Indigenous staff in the four schools were sought with no direct comparisons made between schools. These interviews have therefore been analysed with an assumption that, in responding to questions, an interviewee provides strong clues about how they are positioned within a school's policies about its Indigenous population and about their relations with the Indigenous students with whom they work. It is argued that a school's expectations of staff, positions the school's relations with the Indigenous student population. In what follows an exploratory synthesis on three types of alignment to Indigenous students is discussed using Figure 1 below. Excerpts from an interview with two Indigenous teacher aides are presented to illustrate the emergent contradictions to be pursued in later visits.

Alignment between teacher aides and Indigenous students

Figure 1 is an exploratory representation of the types of alignment between a school and its Indigenous population as developed from eight interviews with Indigenous workers. The positions they filled ranged from Indigenous relations officers to general aides for Indigenous students to classroom teacher aides for all primary school students. The interviews were conducted either with individuals or in pairs and lasted for thirty minutes to an hour. The responses of the interviewees provided some information about the place of their role within the structure of their school and how this role was organised to allow for some planning and insights into cultural factors influencing the learning of the Indigenous students.

Figure 1: Forms of alignment between teacher aides and Indigenous students



Various types of alignment are suggested in Figure 1. In the employment of teacher aides (shown on the horizontal axis) a school can employ all Indigenous workers, some Indigenous aides or all non-Indigenous staff to work with all students, including those who are Indigenous. The choices made about staff appointments relate to government funding received for Indigenous enrolments. Aides are employed for all students when Indigenous enrolments are low. The appointment of Indigenous staff increases as percentages of Indigenous to non-Indigenous students rise. A second consideration, reflected in the vertical axis of Figure 1, is about school organisation and how the school organisation responds to the language and culture Indigenous students bring to the school. The more a school attends to knowledge of the culture and the language as a staffing priority in the employment of staff the inverse attention is focused on providing individualised instruction for all, including Indigenous students. It is therefore possible now to use these insights as starting positions in the analysis of Indigenous learning. Using the second set of conditions listed above helped to identify some emergent contradictions that teacher aides experienced in classroom relations between teachers and Indigenous students.

Emergent contradictions

The contradictions raised here are examples provided by Kathryn and Sonia (names have been changed) who are “general aides” working with Prep to Year 7 classes in a school of around 350 students. Kathryn, of Aboriginal descent, works with Indigenous and non-Indigenous students in 15 classrooms. Sonia, from the Torres Strait Islands, advises and teaches about Torres Strait Island culture and dance to both Indigenous and non-Indigenous students. When asked both women say; “Yes,

this is a good school, we're well looked after". During our interview both women, as mothers, make comparisons with the education of their children and what they see as cultural misunderstandings in teaching in their school. Each enjoys the contact with students, staff and parents and the chance to "think I've melted that barrier a little bit".

Some contradictions in their roles are identified in the following excerpts from our interview. Taken out of context their comments could be seen as criticisms, but they are in fact barriers they would like to surmount in an environment that is supportive of Indigenous education, and which takes this as an important part of the school's dedication to education for all students. Three areas are presented for an understanding of where more attention is required.

School/teacher language, switching codes to accommodate set classroom tasks

In the following excerpt a general misunderstanding of variations between school/teacher language and the problems of switching codes for Indigenous students to accommodate set classroom tasks becomes apparent. This is an area for further development.

Sonia: I think language is one of cultural barrier for them. I speak the Torres Strait Creole the majority of the time at home with my kids and so they're based around that 100 per cent. When they're in the community or when they come to school they need to code switch and speak English in order to - sometimes when they deliver their answer in English it doesn't come out right but the teacher doesn't understand.

Kathryn: When it comes to writing, our Indigenous boys they can talk fine in the classroom but when it comes to writing it's in Pidgin English. It's the way we understand it. The teachers, they come to us and say he's got problems, he can't write a sentence right. Hey, let's think about the non-Indigenous students, some of them can't write a sentence properly. They leave words out, why can't our kids leave words out. It needs to be accepted on both sides. You've got to understand how they talk at home. You can't stop that language from being spoken at home.

Bringing a cultural understanding to mathematics teaching

In this excerpt the "general aides'" views on bringing a cultural understanding to mathematics teaching are made explicit.

Kathryn: No, they don't like it (mathematics), they struggle. Most of them tell me that "(I'm not good at maths). I think it's all off the board and on a piece of paper, more than hands on. Some of the teachers think the kids are going to play with the blocks but we want to teach them, show them that there's an easier way to understand hundreds, tens and ones. Our kids are more hands on aren't they? You're going to have to give them something in front of them to get them finished - even started.

Sonia: Maths is a big up hurdle for a lot of Torres Strait kids. The new way of doing simple addition is just so confusing because I don't understand it, yes. I can't help my kids so I need to - but I see a lot of our teachers have a teachers' book that they carry in front of them when they do maths. They refer back to that book the whole time. I find the children understand it but they have a mental block, I don't know. I have to ask, "oh, can you go back, I lost you there can we you know?". And they always go back which is good. Then I know where I am. A Torres Strait Islander teacher was saying how maths differs here, mainstream, to the remote where they are up in the Torres Strait. For example, if you are to ask a child a question like how long does it take from Townsville to Cairns, he'll tell you in kilometres or in hours.

Whereas if you're asking a child in the Torres Strait, how long does it take from Thursday Island to Badu Island he'll tell you how many petrol drums you need. Rather than the distance in kilometres and hours that is totally different.

Relations with teachers as co-partners in furthering Indigenous learning

Finally in this excerpt the "general aides" express their frustrations about their relations with teachers as co-partners in furthering Indigenous learning.

Kathryn: We get new teachers in every year so we have to guide them and say this child here needs extra help; we know the children and who needs help and who doesn't need help. Sometime the teachers aren't aware. They think that children have a problem because they don't know the work but teachers don't look at the background and what's happening at home.

I think that we might not have that piece of paper that teachers have but we can educate the teachers how to teach our children. That's where we can come in. We need to talk, have that conversation between one another. We talk about children but not how to teach the children. Yes, you talk about children that didn't cope with it, they couldn't do this, or what has so and so done – "but what about how we're going to teach them?"

Interviewer: You would like to be working together on how to teach kids?

Sonia: Yes, rather than you're a teacher and I'm a teacher aide full stop. "I've got the certificate and the number there on that certificate to say that I'm a qualified teacher. I've been teaching for so many years" sort of thing; and, "you do what I say."

These contradictions and tensions illustrated in these three excerpts illustrate some of the barriers to be overcome so that the "general aides" can fully participate in the teaching and learning efforts to improve Indigenous student achievement in the learning area of mathematics.

Conclusion

Underpinning the pedagogical and assessment approach is a broader view of how mathematics is taught in schools, one that encompasses students' understandings, dispositions, self-beliefs and acknowledges their personal view of the value of learning mathematics. Rich tasks (Luke, 2005) and open-ended questioning provide a basis for authentic problem solving to enhance personal and intrinsic motivation, perseverance and resilience. Students' attitudes to learning are directly affected by the value they place on learning and the success they believe they might have in reaching a satisfactory goal.

This research has identified some key issues that now need to be addressed in building teachers' assessment capacity and expertise in the teaching of mathematics for the improvement of learning outcomes for all students including those for Indigenous students. The study aims to continue to focus on improving learning through strategic and effortful teaching that encompasses a diagnostic and holistic view of the student's background, culture, language and demeanour for developing mathematical thinking skills.

References

ACDS [Australian Council of Deans of Science]. (2006). *The preparation of mathematics teachers in Australia: Meeting the demand for suitably qualified*

mathematics teachers in secondary schools. Centre for the Study of Higher Education: The University of Melbourne.

Alloway, N., Gilbert, P., Gilbert, R., & Muspratt, S. (2004). *Factors impacting on student aspirations and expectations in regional Australia*. Canberra: Department of Education, Science and Training.

Assessment Reform Group. (1999). *Assessment for learning: Beyond the black box*. Cambridge, UK: University of Cambridge School of Education.

Beresford & Partington. (2003) *Reform and Resistance in Aboriginal Education: The Australian Experience*. UWA Press: Crawley.

Berlack, H. 2001. Race and the achievement gap. *Rethinking Schools Online* 15, no. 4. <http://www.rethinkingschools.org/archive/04/Race154.shtml> (accessed October 31, 2008).

Brown, A. (1992) "Design experiments: theoretical and methodological challenges in creating complex interventions in classroom settings", *Journal of the Learning Sciences*, 2(2), 141-178.

Brown, G. (2009). *Review of Education in Mathematics, Data Science and Quantitative Disciplines: Report to the group of eight universities*. Canberra: Go8.

Bruner, J. S. (1986) *Actual minds, possible worlds*. Cambridge, Mass.: Harvard University Press.

Davidson, T. (2005). *The language of Maths*. Literacy and numeracy in the middle years. Final Report Far North Cluster of Indigenous Schools. Canberra: DEST.

De Bortoli, L. and S. Thomson. 2009. *The achievement of Australia's Indigenous students in PISA 2000-2006*. Melbourne, Australia: ACER Press.

Department of Education, Science and Training (DEST). 2007. *What Works. The Work Program: Core Issues 4: Numeracy*. <http://www.whatworks.edu.au> (accessed 21 May, 2009).

Dweck, C.S. (2000). *Self Theories: Their Role in Motivation, Personality, and Development*. Psychology Press: Philadelphia.

Engestrom, Yrjo. (2000) "Activity theory as a framework for analyzing and redesigning work". *Ergonomics* 43(7), pp: 960 – 974.

Fincham, D.S., Hokoda, A. & Sanders, F. (1989). Learned helplessness, test anxiety, and academic achievement: A longitudinal analysis. *Child Development*. 60, pp. 138-145.

González, N., Moll, L., Floyd Tenery, M., Rivera, A., Rendón, P., Gonzales, R., & Amanti, C. (2008) Funds of Knowledge for Teaching Latino Households, in K. Hall, P.

Murphy, & J. Soler, *Pedagogy and Practice Culture and Identities*, Milton Keynes, UK: Open University.

Gorard, S Karen Roberts K, Chris Taylor, C. (2004) "What Kind of Creature Is a Design Experiment"? *British Educational Research Journal*, 30(4), pp. 577-590

Kelly, A. (2003) "Research as design", *Educational Researcher*, 31(1), pp. 3-4.

Kearney, J. (2008). *Barriers and bridges to educational success for Pan Pacific Islander students in South East Queensland*. Education Queensland: Sunshine Coast Region.

Kilpatrick, J., Swafford, J. & Findell, B. (2001). *Adding It Up: Helping Children Learn mathematics*. Washington, DC: National Academy Press.

Klenowski, V. and Gertz, T. (2009) *Culture-fair assessment: Addressing equity issues in the context of primary mathematics teaching and learning*, Paper presented at the Australian Council of Educational Research Conference, Perth, Western Australia.

Lokan, J., Greenwood, L. & Cresswell, J. (2001). *15-up and Counting, Reading, Writing, Reasoning. How Literate are Australia's Students?* Melbourne: ACER Australian Council for Educational Research.

Luke, A. (2005) Report on rich tasks

<http://education.qld.gov.au/corporate/newbasics/html/library.html#Report>

Masters, G. (2009). *A Shared Challenge: Improving Literacy, Numeracy and Science Learning in Queensland Primary Schools*. Melbourne: ACER Australian Council for Educational Research.

McGaw, B. (2004). Australian mathematics learning in an international context. In I. Putt, R. Farragher, and M. McLean (eds.), *Mathematics Education for the Third Millennium: Towards 2010. Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia*, p. 29 Townsville: MERGA.

McPhan, G., Morony, W., Pegg, J., Cooksey, R., & Lynch, T. (2008). *Maths? Why not?* Retrieved May 23, 2009, from http://www.dest.gov.au/NR/rdonlyres/6A16AECA-BC08-4187-A639-55AA9FACDBD2/21030/Maths_WhyNot_sml.pdf

McTaggart, R. & Curro, G. (2009). *Book Language as a Foreign Language: ESL strategies for Indigenous Learners*. Toowong: QCOT

- NCB (National Curriculum Board), (2009). *Shape of the Australian Curriculum: Mathematics*. Barton: Commonwealth of Australia.
- Queensland Board of Teacher Registration, (2005). *Numeracy in Teacher Education - The way forward in the 21st Century*. Brisbane: QBTR.
- Rogoff, B. (1995). Observing sociocultural activity on three planes: Participatory appropriation, guided participation, and apprenticeship In J. V.
- Rogoff, B. (2001). Student assessment for the information age. *The Chronicle of Higher Education*, 48(3), B17.
- Rogoff, B. (2003). *The cultural nature of human development*. Oxford, UK: Oxford University Press.
- Sarra, C. (2009, February 26). Indigenous Education needs a magic bullet. *The Australian Online*. June 8, 4.07pm
AEDT.<http://www.theaustralian.com.au/news/opinion/indigenous-study-needs-magic-bullet/story-e6frg6zo-1111118965086>
- Stiggins, R. (2007) Assessment through the student's eyes. *Educational Leadership*, 67, 8, 22-26.
- Stiggins, R. J. (1987). The design and development of performance assessments. *Educational Measurement: Issues and Practice*, 6, 33-42.
- Stobart, G. (2008). *Testing times: The uses and abuses of assessment*. London: Routledge.
- Sullivan, P., Tobias, S., and McDonough, A. (2006). Perhaps the decision of some students not to engage in learning mathematics in school is deliberate. *Education Studies in Mathematics*. 62 (1), 81-99.
- Victorian Parliament, (2006). *Education and Training Committee report: Inquiry into the promotion of mathematics and science education*. Melbourne: Victorian Government Printer.
- Vygotsky, L.S. (1962). *Thought and language*. Cambridge, MA: MIT Press. (Original work published 1934)
- Vygotsky, L.S. (1978). *Mind in Society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Watt, H. (2005). Exploring adolescent motivations for pursuing maths-related careers. *Australian Journal of Educational and Developmental Psychology*, 5(2005), 107-116.
- Wertsch, P. del Rio & A. Alvarez (Eds.), *Sociocultural studies of mind* (pp. 139-164). Cambridge, UK: Cambridge University Press.

Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. London: Harvester Wheatsheaf.

Wertsch, J. V. (1995). The need for action in sociocultural research. In J. V.

Wertsch, P. Del Rio & A. Alvarez (Eds.), *Sociocultural studies of mind* (pp. 56-74). Cambridge, MA: Cambridge University Press.

Wiggins, G. (1989) A true test: Toward more authentic and equitable assessment. *Phi Delta Kappan*, 70, 9 (May).

Wiggins, G. P. (1993). *Assessing student performance*. San Francisco: Jossey-Bass Publishers.

Wiggins, G. P. (1990). The case for authentic assessment. *Practical Assessment, Research & Evaluation*, 2(2).

Yates, S. (2009). Teacher Identification of Student Learned Helplessness in Mathematics. *Mathematics Education Research Journal*. pp. 86-106. 21(3).

Zevenbergen, R., Mousley, J. & Sullivan, P. (2004). Making the pedagogic relay inclusive for indigenous Australian students in mathematics classrooms, *International Journal of Inclusive Education*, 8(4) pp. 391-405.